THE EFFECT OF BREATHING TECHNIQUES ON THE END-TIDAL PERCENTAGE OF CARBON DIOXIDE AND ITS IMPORTANCE DURING LABOUR[1]

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This experiment was undertaken to determine the connection between the breathing techniques practised in some methods of training for childbirth and the presence of certain undesirable side effects during labour. These symptoms, *viz.*, dizziness, exhaustion, shortness of breath, "pins and needles", tremors and tetany, may be the result of hyperventilation and the ensuing hypocapnia (deficiency of CO_2 in the blood) (Christophers, 1961).

Since this experiment was done, the results have become more significant as recent reading suggests that maternal hyperventilation may have more serious effects than discomfort to the mother; it may cause foetal anoxia (Reid, 1966; Motoyama *et al.*, 1966).

The breathing techniques examined were slow diaphragmatic breathing and fast upper chest breathing.

METHOD

A Godart Capnograph infra-red CO_2 analyser was used to measure the effect of the breathing techniques on the end-tidal CO_2%. The analyser gives an instant reading of the end-tidal CO_2%, but when breathing becomes too fast it cannot give a reliable reading and we can only observe what has happened by reading the graph of subsequent breaths. For example, if subsequent CO_2% readings are high, it indicates that CO_2 has accumulated during the fast breathing stage.

The subject was seated in a comfortable position, a small plastic tube taped just inside the nose, and the other end attached to the analyser. From the graph it can be seen that the normal breathing pattern resulted in an end-tidal CO_2% about 4.6%-4.8% (Diag. 1a) (Alveolar carbondioxide tension 33 mm. Hg.).

Slow diaphragmatic breathing was done for 1 minute and the end-tidal CO_2% was unaffected. (Diag. 1a.)

The fast breathing techniques were then tried and, as is the usual practice, preceded each time by a deep breath in and out.

Fast shallow upper chest breathing was done for 1 minute. After this breathing there was a momentary increase in the end-tidal CO_2% with the first breath, 5.6% (40 mm. Hg.), and then with the second breath the percentage fell and stabilized about 4.6% 33 mm. Hg.) (Diag. 1b). There was therefore no significant change in the breathing pattern.

Fast deep upper chest breathing was done for 1 minute. The end-tidal CO_2% decreased to 3.6% (26 mm. Hg.) with the subsequent first two breaths, fell as low as 3% (21 mm. Hg.) during the next minute, then rose slowly taking a considerable time, about ten minutes, to reach 4.6% (33 mm. Hg.) again (Diag. 1c). Thus the subsequent low end-tidal CO_2% after the period of fast deep breathing indicates that CO_2 was "washed out" during the period of fast breathing.

It is concluded from the above that the shallow fast breathing is the correct technique causing no loss of CO_2 and undesirable side effects. When the fast breathing becomes too deep, this overbreathing or hyperventilation can result in hypocapnia.

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Manoeuvres which might prevent or correct the loss of CO_2 during the fast deep breathing period were then tried.

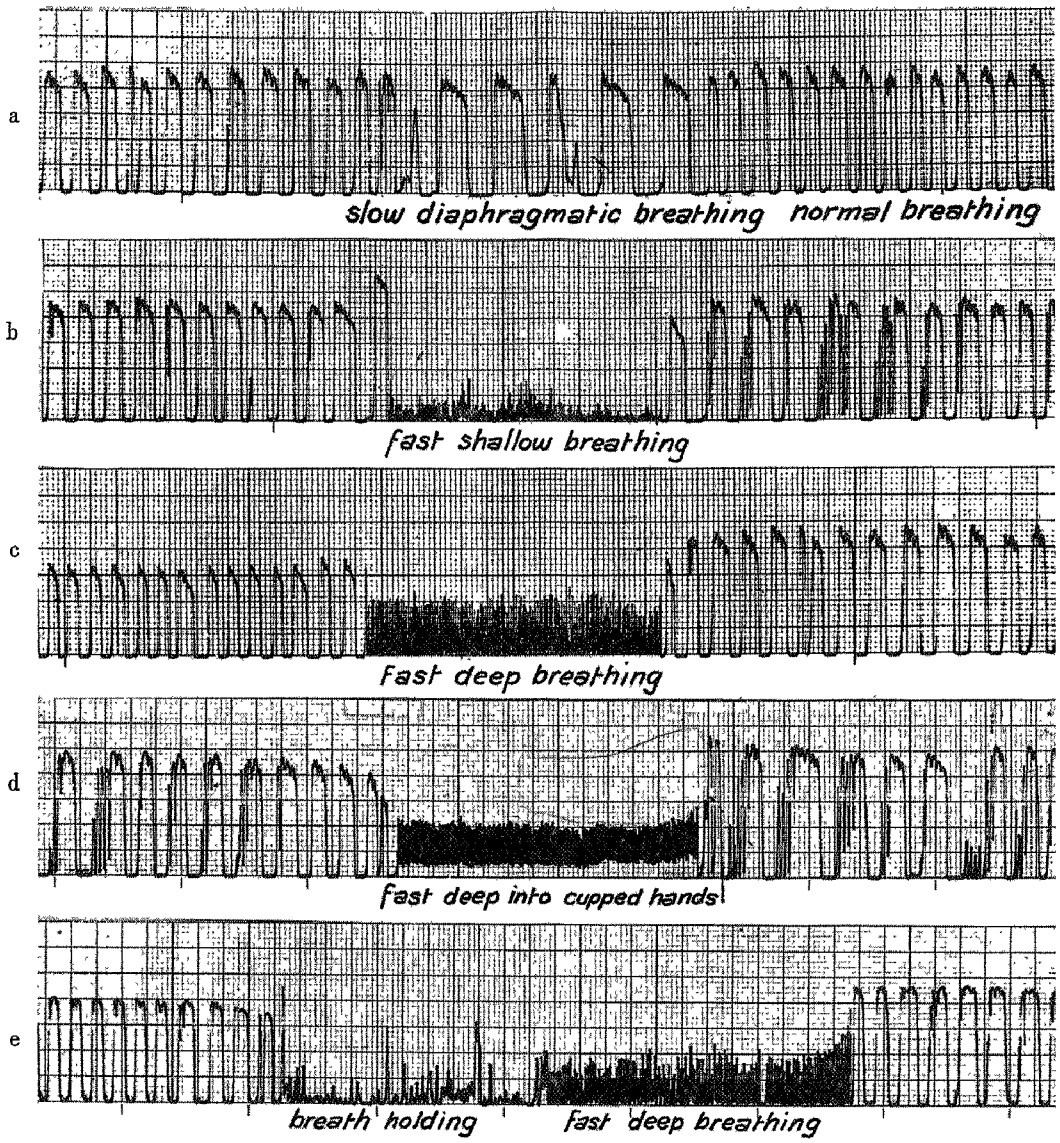

DIAGRAM 1

Effect of Breathing Techniques on End-Tidal CO_2%.

Records read from right to left.

Vertical Scale, CO_2%. 1 Large Square = 1%. Horizontal Scale, Time. 1 Large Square = 5 secs.

Fast deep breathing was done into cupped hands for 1 minute. At first there was a drop in the end-tidal CO_2% to 3% (21 mm. Hg.), but this quickly rose again to 4.6% (33 mm. Hg.) by the fourth breath (Diag. 1d). By this rebreathing process the alveolar CO_2 was not appreciably lost and full recovery took about ¼ minute.

Fast deep breathing was done for 1 minute and followed immediately by holding the breath for a comfortable time. This time the CO_2% fell to 3.4% (24 mm. Hg.) and recovery took a considerable time. (Diag. 1e.)

The first of these techniques was found to be the most comfortable and would probably be the most reliable as variations in the length of time the breath was held would influence the build-up of CO_2. Also it would seem preferable to restrict the drop of end-tidal CO_2% by breathing into cupped hands rather than restore it by holding the breath after it had already reached a low level during the time of fast breathing.

It was questioned whether the CO_2 level could be affected even further if the fast deep breathing was used for 1 minute every 2 minutes, as it would be by a patient in labour. The subject again did the fast deep breathing for 1 minute, then rested for 2 minutes. This procedure was repeated ten times. It can be seen from Diagram 2 "Initial" that the initial CO_2% reading immediately after the periods of fast deep breathing fell progressively until after the fourth successive fast breathing period and thereafter reached a plateau at 2.4% (17 mm. Hg.). After a few stabilizing breaths in the rest periods Diagram 2 "Stabilized" shows that the end-tidal CO_2% also progressively decreased and then levelled at 2.8% (20 mm. Hg.).

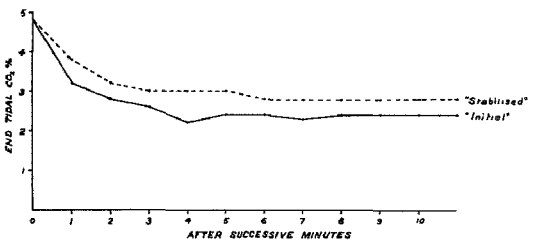

DIAGRAM 2

Effect of Repeated Fast Deep Breathing on CO_2 Level.

Thus when the fast breathing was used for 1 minute every 2 minutes, CO_2 was "washed out" even more, but after 10 minutes the loss appeared to be limited and reached a plateau although the breathing technique was continued for some time. However the percentage did not have time to build up again to the normal during the periods of rest as long as the fast breathing was applied at 2 minute intervals.

DISCUSSION

There is experimental evidence (Motoyama *et al.*, 1966) using ewes and lambs showing that when maternal hyperventilation is accompanied by hypocapnia there is a consistent decrease in foetal O_2 tension. The decrease in foetal carotid O_2 tension is thought to be the combined result of a decrease in O_2 transfer in the placenta and a decrease in umbilical blood flow.

Moya *et al.* (1965) reported the birth of two human babies with hypoxia and acidosis following maternal hyperventilation during uncomplicated labours.

They also found that foetal asphyxia was more likely to occur if arterial CO_2 tension fell below 17 mm. Hg. This observation was made with the mother undergoing Caesarian section, under the effect of anaesthesia and therefore being artificially hyperventilated.

Hyperventilation may be inadvertently encouraged during labour by the faulty teaching or application of fast breathing techniques. Since this maternal hyperventilation can be unpleasant for the mother and may be harmful to the baby, we must ensure that patients are instructed carefully and taught how to take corrective measures should they become necessary.

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